# ESTIMATING THE AMOUNT OF CLOUD COVER (IN OKTAS) USING PHOTOVOLTAICS

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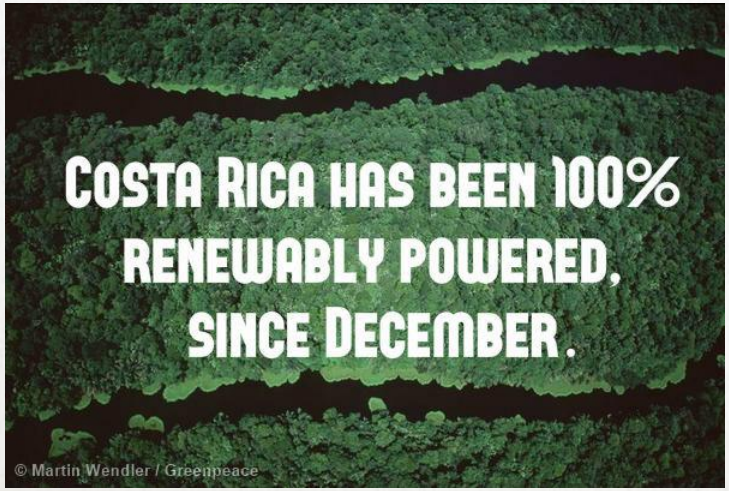
16th EMS / 11th ECAC | 12–16 September 2016 | Trieste, Italy

# OUTLINE

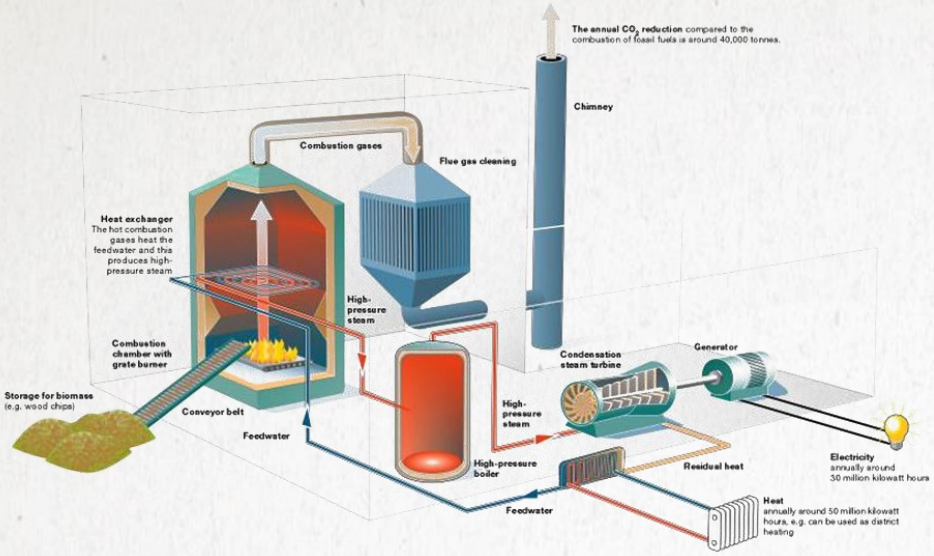
- Introduction
- Methodology
- Results
- Conclusions
- Next Steps

# INTRODUCTION



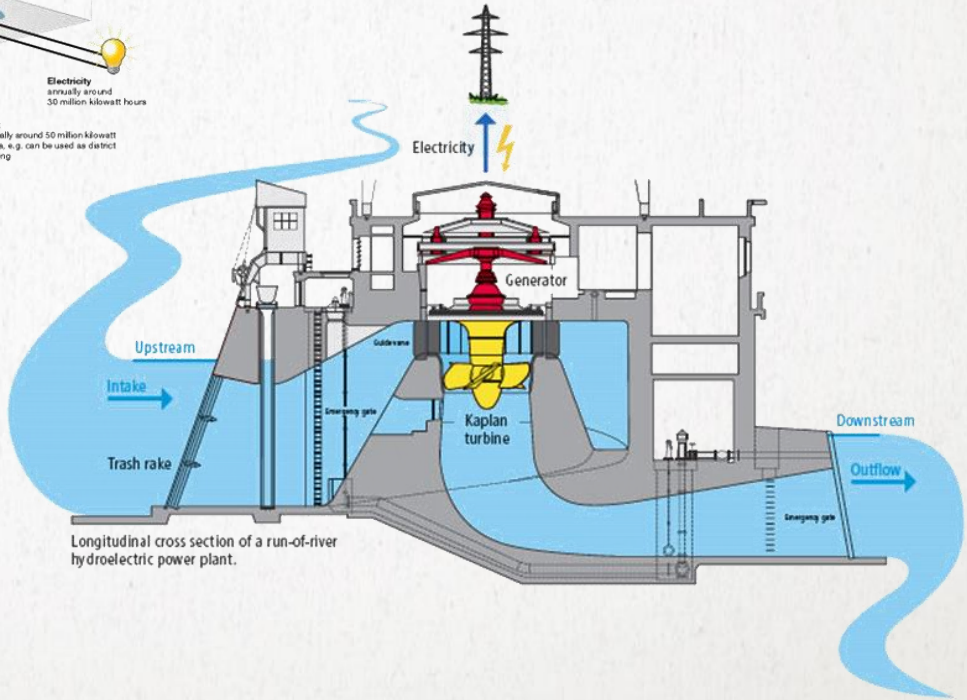




# PROBLEM




Biomass Energy

Hydro Energy



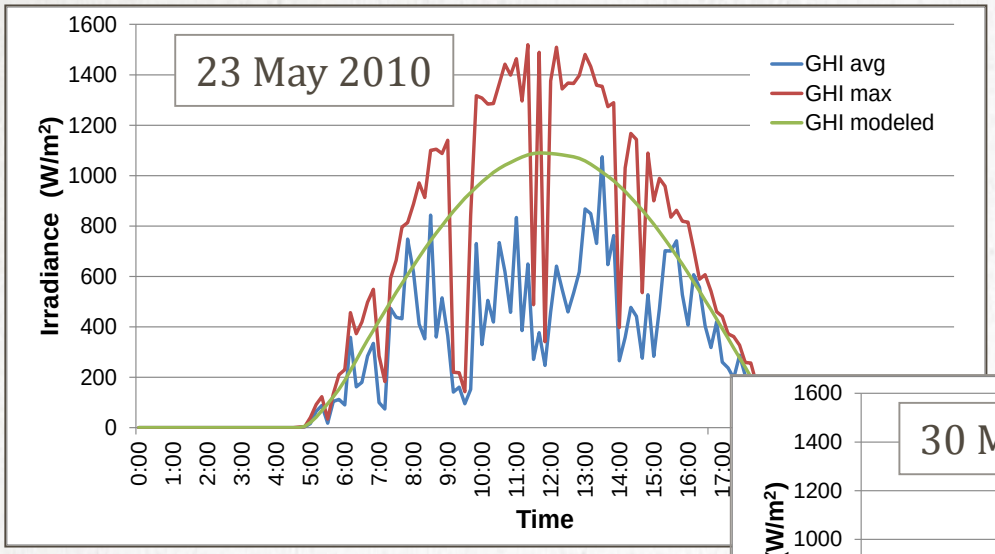
# PROBLEM

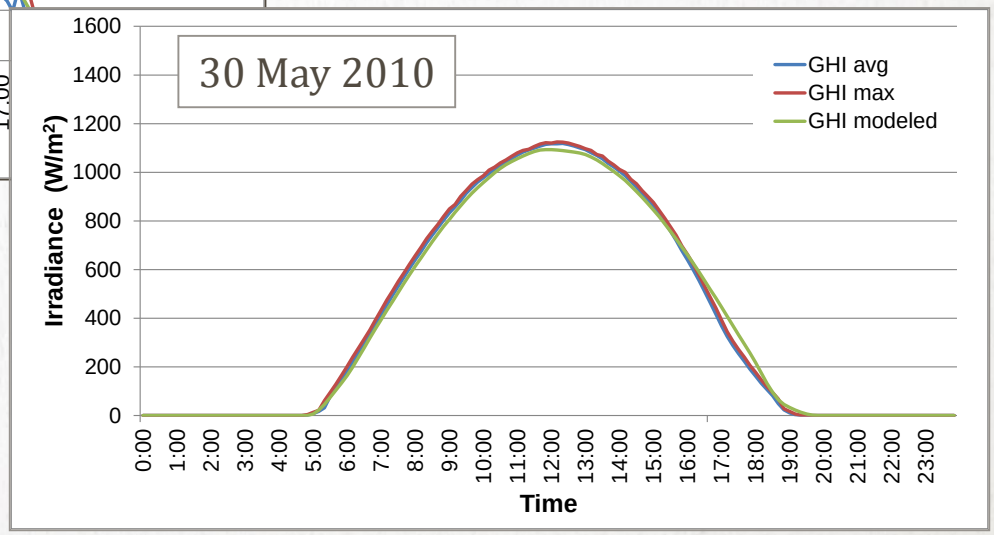

Solar
Energy

Wind
Energy

# PROBLEM

Why is variability a problem?



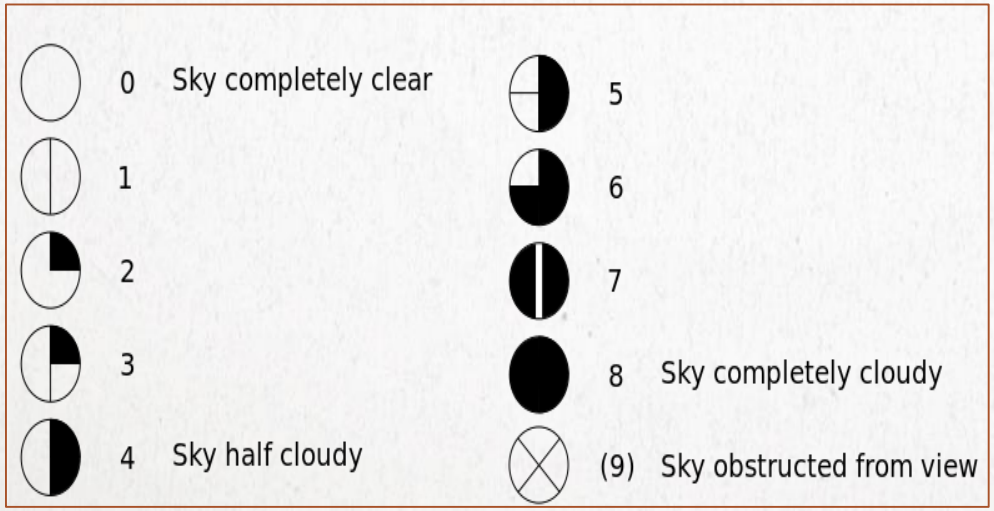



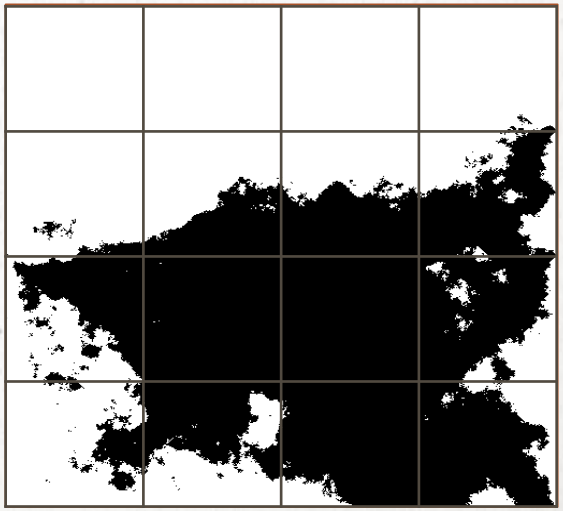

- Transmission System Operators: Grid Stability
- PV owners: Improve Profit Margins

(Renewable Energy 62 (2014) 459-467)

# METHODOLOGY

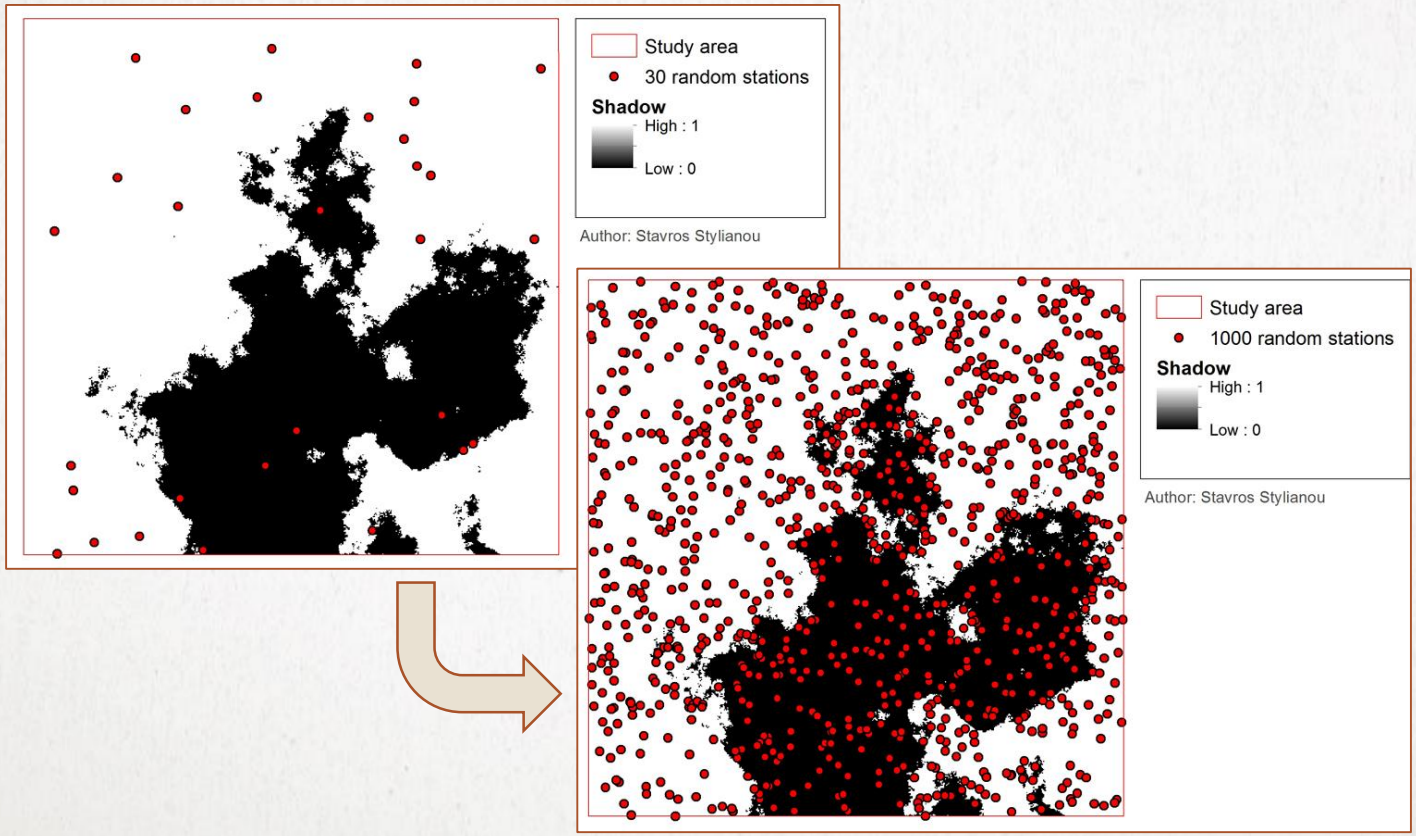
- Each okta represents one eighth of the sky covered by cloud.
- Ranging from 0 oktas (completely clear sky) through to 8 oktas (completely overcast).



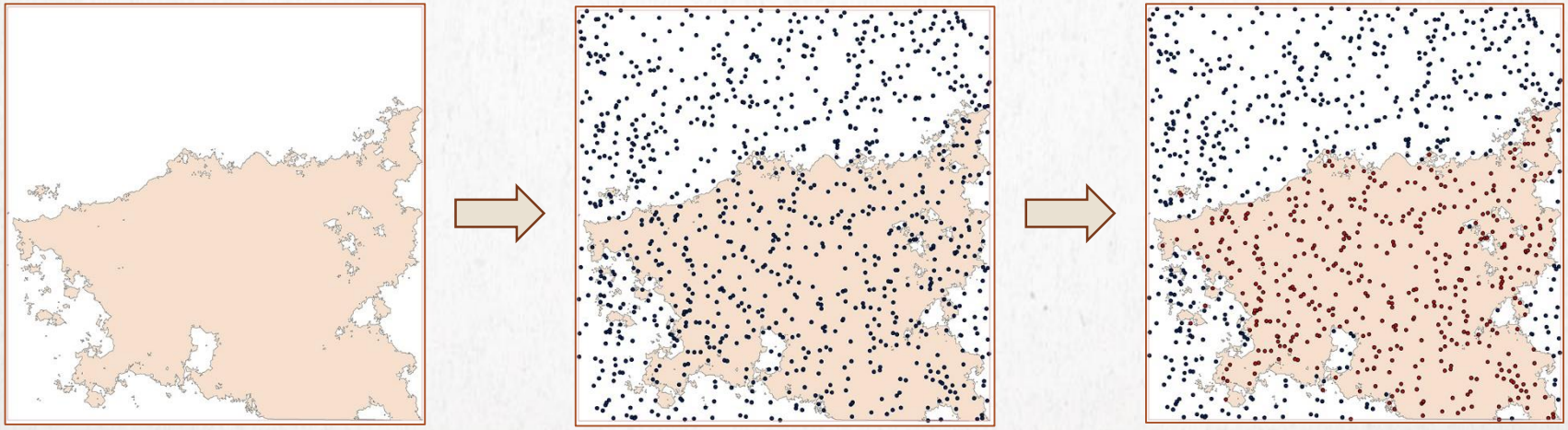
# METHODOLOGY

- Six different scenarios carried out using 30, 50, 75, 100, 500 and 1000 randomly distributed PV systems in an area of 10km x 10km.



# METHODOLOGY

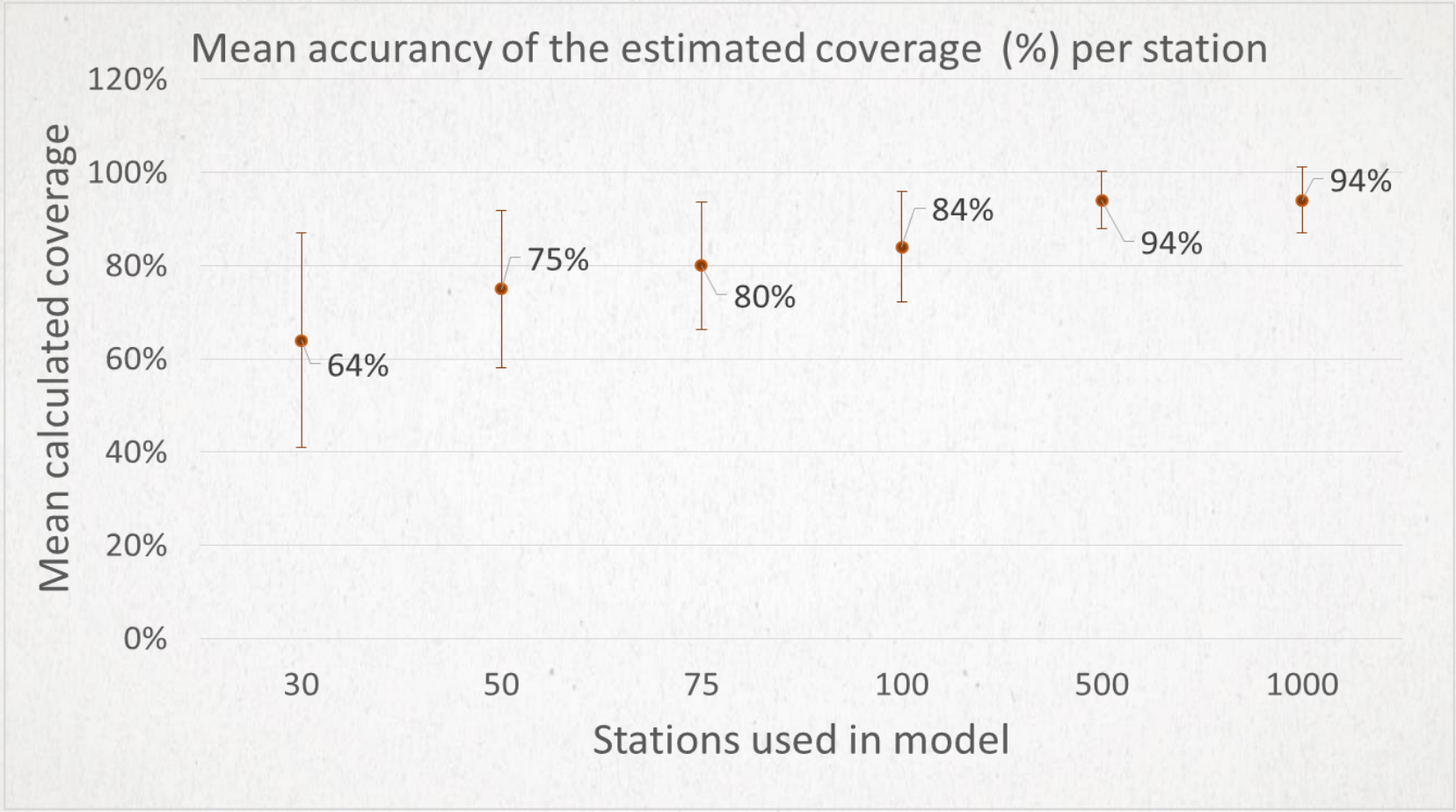
- 350 different fractal-based cloud shadows (50 per okta) were produced.
- Utilize geographic information systems (GIS) geoprocessing to calculate cloud coverage.



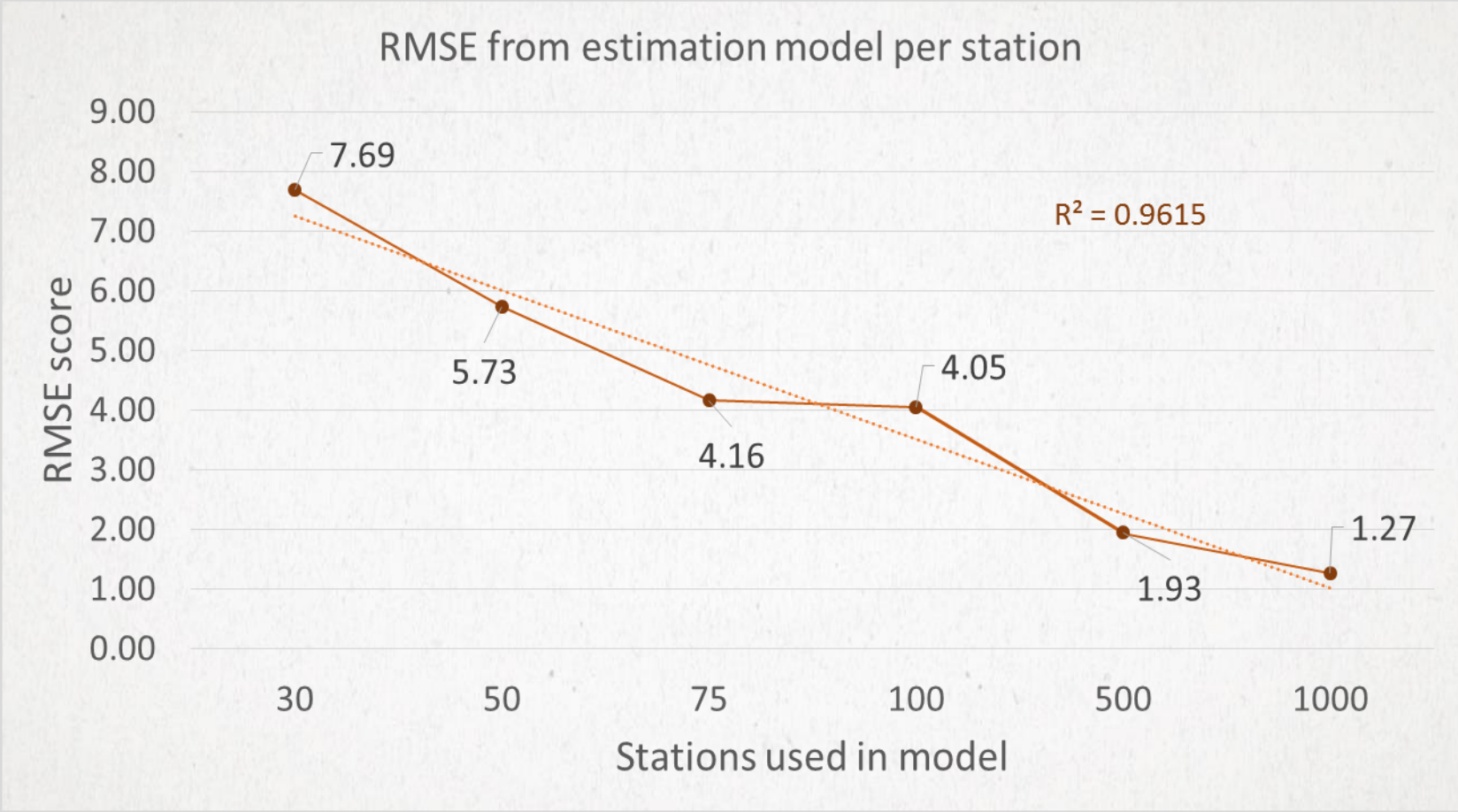
# RESULTS

| OKTA | STATIONS - calculated coverage (%) per OKTA | | | | | |
|---|---|---|---|---|---|---|
| | 30 Stations | 50 stations | 75 Stations | 100 stations | 500 Stations | 1000 Stations |
| **0** | 100% | 100% | 100% | 100% | 100% | 100% |
| **1** | 60% | 80% | 84% | 90% | 100% | 98% |
| **2** | 48% | 76% | 76% | 84% | 94% | 86% |
| **3** | 66% | 62% | 72% | 74% | 86% | 80% |
| **4** | 52% | 50% | 60% | 74% | 86% | 92% |
| **5** | 44% | 64% | 66% | 68% | 88% | 90% |
| **6** | 36% | 66% | 80% | 76% | 98% | 98% |
| **7** | 68% | 78% | 78% | 92% | 98% | 98% |
| **8** | 100% | 100% | 100% | 100% | 100% | 100% |
| | | | | | | |
| **Mean** | 64% | 75% | 80% | 84% | 94% | 94% |
| **Standard Deviation** | 0.2294 | 0.1688 | 0.1366 | 0.1189 | 0.0614 | 0.0705 |

# RESULTS


Mean accurancy of the estimated coverage (%) per station
Mean calculated coverage
120%
100%
80%
60%
40%
20%
0%
64%
75%
80%
84%
94%
94%
30
50
75
100
500
1000
Stations used in model

# RESULTS


RMSE from estimation model per station
RMSE score
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
7.69
5.73
4.16
4.05
1.93
1.27
R² = 0.9615
30
50
75
100
500
1000
Stations used in model

# CONCLUSIONS

- There is a positive correlation between the number of stations used and the accuracy of the estimation.
- With 30 PV stations an average accuracy of only 64% was produced. The accuracy increased to 94% with 1000 PV stations.
- PV data can provide interesting meteorological information.
- The developed model can provide a solid cloud cover estimation.

# NEXT STEPS

- To run the model with real data from PV.
- To validate the results using meteorological data and sky cameras.
- Analyze the results with a meteorology specialist.
- Further develop to estimate cloud movement.

# QUESTIONS ?